Tests of *CP* and *CPT* symmetry with positronium

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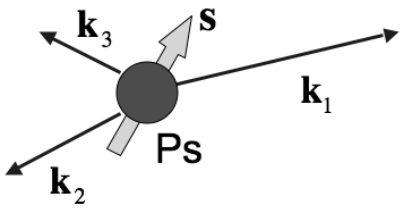

Figure 1: The 3γ decay of the triplet positronium. $\mathbf{s}$ is the positronium spin, $\mathbf{k}_n$ are the momenta of the 3γ's ($|\mathbf{k}_1| > |\mathbf{k}_2| > |\mathbf{k}_3|$).

The 3γ decay of spin-aligned triplet positronium can be used to test the *CP* (*C*=charge conjugation, and *P*=parity operation) invariance in the lepton sector. The *CP* violating angular correlation, $(\mathbf{s}\cdot\mathbf{k}_1)(\mathbf{s}\cdot\mathbf{k}_1\times\mathbf{k}_2)$, is measured for this test, where $\mathbf{s}$ is the positronium spin and $|\mathbf{k}_1| > |\mathbf{k}_2| > |\mathbf{k}_3|$ are the γ momenta (Fig. 1) [1].

In this talk, we will show our new detector design to investigate *CP* asymmetry with an uncertainty of $\sim 10^{-3}$, which is about 10 times higher sensitivity than a previous experiment [2]. In our setup, a $^{22}\mathrm{Na}$ source is used to supply positrons, and positroniums are created in silica aerogel. For the spin alignment of the positroniums, a magnetic field of approximately 3.5 kG is applied. LYSO scintillators are used as the γ-ray detectors to obtain good energy and timing resolutions. All the detectors are rotated around the positronium source for the cancellation of the systematic errors. The detailed setup and the current status of our experiment will be reported.

We also discuss a test of the *CPT* (*T*=time reversal) invariance which can be tested with a similar setup. In this *CPT* test, another angular correlation, $\mathbf{s}\cdot(\mathbf{k}1\times\mathbf{k}2)$, is measured [3, 4].

References

[1] W. Bernreuther *et al.*, Z. Phys. C, **41**, 143 (1988).

[2] M. Skalsey and J. Van House, Phys. Rev. Lett., **67**, 1993 (1991).

[3] B. K. Arbic *et al.*, Phys. Rev. A, **37**, 3189 (1988).

[4] P. A. Vetter and S. J. Freedman, Phys. Rev. Lett., **91**, 263401 (2003).